Least Square Method Technique for Predicting the Acquisition of Raw Materials and Sales of Crisp for Small and Medium Enterprises

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Abstract: ***Small and Medium Enterprises (SME) are companies that usually run in rural areas and is part of the initiatives by the government to increase the economy of the rural population. A case study was conducted on a SME company, Teguh Enterprise Sdn Bhd which sells various types of chips based on local products such as sweet potatoes, bananas, breadfruits and others. Acquisition of raw materials for product produce as well as revenue from monthly sales of products are important information for a company as means to sustain its operations. However, that information is usually unstable and difficult to predict even though the forecast of the products needs to be done to obtain optimum revenue. This is because there is a demand for raw materials increase and sometimes decreases. Based on the products' forecast, SMEs will be able to produce and manage their products more efficiently. This study uses the Least Square Method (LSM) as a measure to forecast the productions of each products and the acquisition of raw materials based on previous data. Based on the result, we can concluded the prediction analysis using LSM can help this company be predict the raw materials and of chips for the future period.***

Index Terms: ***BBQ potato, least square method, sales prediction, salted potato.***

I. INTRODUCTION

A small and medium enterprise (SME) is a company located in rural or suburb and is a government effort to eradicate poverty and reduce the income gap between urban and rural populations. There are many definitions that refer to the meaning of SME. Based on [1], there are 55 different definitions in 75 countries in the world. If based on the Malaysian Ministry of International Trade and Industry (MITI) report, a small industry means a manufacturer with paid capital of not more than RM0.5 million or having full-time employees not more than 50 persons. While the medium industry means ownership of assets between RM0.5 million and RM2.5 million or having between 50 and 199 employees. Accordingly, the SME is defined as an industry whose assets do not exceed RM2.5 million or the number of its employees does not exceed 200 full-time employees [1].

It plays an important role in providing job opportunities and platforms for each individual to become an entrepreneur and thus a catalyst for large-sized industries [2], [3]. To become a successful entrepreneur, it is closely linked to the development of individual capabilities in the business undertaken and thereby enhance the management capabilities in the business [4]. The ability of SMEs to play a key role in determining the success of a business and aims at personal leadership capabilities, management skills and proactive capabilities [5].

This study looks at the factor of proactive capability of an entrepreneur to predict sources (e.g., bananas, sweet potatoes and potatoes to be processed in chip production) and sales produced by the product. This case study involves SMI-Usaha Gigih Enterprise which sells various types of chip either directly, wholesale or online. One of the constraints faced by the company is the provision of resources for chip production where there are cases of chip shortage but have high demand and vice versa. Hence, it is important to predict the source so that the above problems can be reduced to maximum revenue generation. The prediction process can be done using previous data or current data.

In making the forecast a statistical method of Least Square Method (LMS) was chosen. This method is most popular as it is simple, easy to understand, calculation it's very fast and in-extensive and because of time series data often exhibits a persistent growth trend [6]. By predicting that resources can help SMEs provide appropriate measures in optimum product creation, business operations are in good condition (sufficient products to demand) and can therefore benefit more.

II. LITERATURE REVIEW

Prediction or forecasting is an important tool in the process of planning for effectiveness and efficiencies, especially in the economic field. In modern organizations, knowing the future situation is very important to look at the good or bad and aimed to give the response for the next activities [7]. Time series analysis, a statistical analysis is one of the methods to predict future conditions. A time series is a collection of data recorded over a period of time for example weekly, monthly, quarterly, or yearly [8]. To

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make a correct and proper prediction, various data and information may be required to be observed on such a relatively long time. Least Squares Method (LSM) is usually used to find the best linear relationship between two variables in linear equation. For example, in forecasting methods, time is the independent variable and the value of the time series is the dependent variable.

Authors in [9] predict the Solar Energy using Least Square Linear Regression Method. In this research, LSM is used to predict solar intensity (dependent variable) and the independent variables (months, temperature, and total amount of cloud, wind speed and humidity). As a result, the authors claim that the prediction models derived using this method outperform a past predicts future models and a simple model based on sky condition forecasts from prior work [10]. In [11], LSM is used to predict the number of student enter in the private college. From the study, the author clamming the proposed prediction model is valid results or closer to the truth. This model predict the number of new students acquisition for the coming period based on the student data in the previous years.

III. LEAST SQUARE METHOD

Linear regression is a prediction algorithm which provides a linear relationship between dependent variable (call is Y) to the values of an independent variable (call is X). For example, in standard formulation, a set of *N* pairs of variable $\{X_i, Y_i\}$ is used to find relation between the dependent and independent variable above. With one the variable and a linear function, the prediction is given by (1) [12]-[13].

$$\hat{Y}=a + bX \quad (1)$$

In this equation, we have two parameters namely a-intercept and b-slope (gradient) of the regression line. The least squares method (LSM) is defined to estimate these parameters as the values which minimize the sum of the squares (least squares) between measurements and the model. Example of this model is the predicted values. Equation (2) is used to minimize the amounts of the sum of the squares:

$$\varepsilon = \sum_i (Y_i - \hat{Y}_i)^2 = \sum_i [Y_i - (a + bX_i)] \quad (2)$$

where ε stand for error which is the quantity to be minimized.

Next, derivative of ε with respect to *a* and *b* is set to zero. It aims is to find the values of *a* and *b* that minimize value (called is normal equations) and is represent as in (3) and (4).

$$\frac{\partial \varepsilon}{\partial a} = 2Na + 2b\sum X_i - 2\sum Y_i = 0 \quad (3)$$

$$\frac{\partial \varepsilon}{\partial b} = 2b\sum X_i^2 + 2a\sum X_i - 2\sum Y_i X_i = 0 \quad (4)$$

Solving the normal equation in (3) and (4), LSM of *a* and *b* are given as in (5) and (6). In (3),

$$2Na + 2b\sum X_i - 2\sum Y_i = 0$$
$$Na = \sum Y_i - b\sum X_i$$
$$a = \sum Y_i / N - b\sum X_i/N$$
$$a = \text{mean}(Y_i) - b\ \text{mean}(X_i)$$
$$= \bar{Y} - b(\bar{X}) \quad (5)$$

$b = \frac{\sum (Y_i - \bar{Y})(X_i - \bar{X})}{\sum (X_i - \bar{X})^2}$ and can be summarized as

$$= \frac{SS_{xy}}{SS_{xx}} \quad (6)$$

where *SS* is the sum of squares and finally SS_{xy}, SS_{xx} and SS_{yy} are calculated as in (7), (8) and (9).

$$SS_{xx} = \sum_{i=1}^{n}(X_i - \bar{X})^2 = \sum_{i=1}^{n} X_i^2 - \frac{(\sum_{i=1}^{n} X_i)^2}{n} \quad (7)$$

$$SS_{xy} = \sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})$$
$$= \sum_{i=1}^{n} X_i Y_i - \frac{(\sum_{i=1}^{n} X_i)(\sum_{i=1}^{n} Y_i)}{n} \quad (8)$$

$$SS_{yy} = \sum_{i=1}^{n}(Y_i - \bar{Y})^2 = \sum_{i=1}^{n} Y_i^2 - \frac{(\sum_{i=1}^{n} Y_i)^2}{n} \quad (9)$$

IV. RESULTS AND ANALYSIS

A. Data Collection

The data used is obtained from a SME company namely Gigih Enterprise with address at Sungai Buaya Village, Banting, Selangor, Peninsular Malaysia. Example of real data is represented in Table 1.

Table 1: Value of sales (RM) and quantity of salt and BBQ

No	Month (2018)	Type of Chips			
		Salt Potato		BBQ Potato	
		Quantity Sales (kg)	Value (RM)	Quantity Sales (kg)	Value (RM)
1	Jan	5,500	44,000	2,100	21,500
2	Feb	4,500	36,000	1,900	19,000
3	Mar	4,500	36,000	1,850	18,500
4	Apr	5,000	40,000	1,800	18,000
5	May	6,500	52,000	2,000	20,000
6	Jun	7,500	60,000	2,500	25,000

B. LSM of Quantity Raw Material and Sales

According to the data in Table 1, we compute the LSM. The steps to calculate LSM as follows:

1. Compute the value of X^2, XY and Y^2.
2. Summation of X^2, XY and Y^2.
3. Calculate the SS_{xx}, SS_{yy} and SS_{xy}

Suggestion in [7], to simplify the calculation, the month in Table 1 is replaced by coded values. For example, Jan 2018 is 1, Feb 2018 be 2 and so forth. This method often referred as code method. The following subsection shows an example of how to calculate the prediction using LSM. Calculation of LSM based on the type of chips of potato is divided into two namely quantity (kg) and sales (RM).

1. Salt Potato Crisp

This subsection describe how to compute LSM for quantity the raw material (kg) and sales (RM) for salt potato.

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1.1a. Quantity of Raw Material for Salt Potato

Table 2: Calculation of LSM for salt potato

No. (X)	Month	Qty. Sales – kg (Y)	X^2	XY	Y^2
1	Jan2018	5500	1	5500	30250000
2	Feb2018	4500	4	9000	20250000
3	Mar2018	4500	9	13500	20250000
4	Apr2018	5000	16	20000	25000000
5	May2018	6500	25	32500	42250000
6	Jun2018	7500	36	4500	56250000
$\sum X$= 21	-	$\sum Y$= 33500	$\sum X^2$ = 91	$\sum XY$= 125500	$\sum Y^2$= 194250000
$\bar{X}$= 3.5	-	$\bar{Y}$=5583	-	-	-

Based on (5), (6), (7) and (8), we compute the value of a and b.

a) Compute SS_{xy} using (8)

SS_{xy} = 125500-((21)(33500))/6
= 125500-117250 = 8250

b) Calculate the value of SS_{xx} using (7)

SS_{xx} = (91)- $(21)^2$ /6
= 91-441/6
=17.5

c) Finally, to obtain the value of a and b, in (6) and (5) are used.

$b = SS_{xy}$ / SS_{xx}
= 8250/17.5 =471.4

From (5), calculation for a:

$a = \bar{Y}$ - b($\bar{X}$)
= 5583- 471.4(3.5)
=5583-1649.9
= 3933

Then, the prediction model is $\hat{Y}=a + bX$,

Y = 3933 + 471.4 (X) (10)

According to (10), the forecasts for July and August 2018 can be calculated by replacing the value of X = 7 and 8 and the values obtained are 7,232.8 kg and 7704.2 kg.

1.1b. Quantity of Sale of Salt Potato

Table 3: Calculation of LSM for salt potato

No. (X)	Month (2018)	Qty. Sales RM (Y)	X^2	XY	Y^2
1	Jan	44,000	1	44000	1936000000
2	Feb	36000	4	72000	1296000000
3	Mar	36000	9	108000	1296000000
4	Apr	40000	16	160000	1600000000
5	May	52000	25	260000	2704000000
6	Jun	60000	36	360000	3600000000
$\sum X$ =21		$\sum Y$= 268,000	$\sum X^2$ = 91	$\sum XY$= 1004000	$\sum Y^2$= 12432000000
$\bar{X}$= 3.5	-	$\bar{Y}$=44667	-	-	-

To obtained the value of a and b, in (5), (6),(7) and (8) are used.

Compute SS_{xy} with used (8)

SS_{xy} = 1004000-((21)(268000))/6
= 1004000-938000
= 66000

Followed by compute SS_{xx} using (7)

SS_{xx} =(91)-(($21)^2$ /6))
=91-441/6
=17.5

And finally, based on (6) and (5) to obtain the value of a and b.

$b=SS_{xy}$ / SS_{xx}
= 66000/17.5
=3771.4

$a= \bar{Y}$ - $b(\bar{X})$
=44667 -3771.4(3.5)
=31466.8

Then, the prediction model is $\hat{Y}=a + bX$,

Y = 31466.8 + 3771.4 (X) (11)

The forecasts for July and August 2018 can be computed using (2) by replacing the value of X = 7 and 8, then the values obtained are RM 57,866.6 and RM 61,638.

2. BBQ Potato Crisp

Calculation for LSM of the quantity raw material (kg) and sales (RM) for BBQ potato are described in this subsection.

2.1a. Quantity of Raw Material for BBQ Potato

Table 4: Calculation of LSM for BBQ potato

No. (X)	Month (2018)	Qty. Sales kg (Y)	X^2	XY	Y^2
1	Jan	2100	1	2100	4410000
2	Feb	1900	4	3800	3610000
3	Mar	1850	9	5550	3422500
4	Apr	1800	16	7200	3240000
5	May	2000	25	10000	4000000
6	Jun	2500	36	15000	6250000
$\sum X$=21	-	$\sum Y$=12150	$\sum X^2$= 91	$\sum XY$= 43650	$\sum Y^2$= 24932500
$\bar{X}$= 3.5	-	$\bar{Y}$=2025	-	-	-

Value of a and b are computed using (5), (6), (7) and (8).

a) Compute SS_{xy} using (8)

SS_{xy} = 43650-((21)(12150))/6
= 1,125

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b) Compute SS_{xx} using (7)
SS_{xx} = (91)-$(21)^2$ /6
= 17.5

c) Compute b using (6)
b = SS_{xy} / SS_{xx}
= 1,125/17.5
= 64.3

d) Compute a using (5)
a = $\bar{Y}$ - b($\bar{X}$)
= 2025-64.3(3.5)
= 1800

e) Then, the prediction model is $\hat{Y}$=a + bX

Y =1800 + 64.3 (X) (12)

Based on (12), forecasts for July and August 2018 can be calculated by replacing the value of X = 7 and 8 and the values obtained are 2250.1 kg and 2314.4 kg.

2.1b. Quantity of Sale of Salt Potato (RM)

Table 5: Calculation of LSM for BBQ potato

No. (X)	Month (2018)	Qty. Sales RM (Y)	X^2	XY	Y^2
1	Jan	21500	1	21500	462250000
2	Feb	19000	4	38000	361000000
3	Mar	18500	9	55500	342250000
4	Apr	18000	16	72000	324000000
5	May	20000	25	100000	400000000
6	Jun	25000	36	150000	625000000
$\sum X$= 21	-	$\sum Y$= 122000	$\sum X^2$= 91	$\sum XY$= 437000	$\sum Y^2$= 2514500000
$\bar{X}$= 3.5	-	$\bar{Y}$=20333	-	-	-

Find the value of a and b using (5), (6), (7) and (8) are used.

a) Compute SS_{xy} using (8)
SS_{xy} = 437000-((21)(122,000))/6
= 10000

b) Compute SS_{xx} using (7)
SS_{xx} = 91-$(21)^2$ /6
= 17.5

c) Compute b using (6)
b = SS_{xy} / SS_{xx}
= 10000 /17.5
= 571.4

d) Compute a using (5)
a = $\bar{Y}$ - b($\bar{X}$)
=20333-571.4(3.5)
= 18333

e) The prediction model is $\hat{Y}$=a + b (X)

Y = 18333 + 571.4(X) (13)

Based on (13), forecasts for July and August 2018 can be calculated by replacing the value of X = 7 and 8 and the values obtained are RM 22,332.8 and RM 22,904.2.

V. CONCLUSION

A small and medium enterprise (SME) is a company promoted by the government to improve the economy of rural people. One of the companies, Teguh Enterprise Company is involved in the sales of various types of chips. For optimal results, it is important to know or make estimates of raw material requirements for future use based on previous data. In this study, a LSM method is used to predict the using of raw materials in the production and sale of chips. With this model of prediction, it helps MSE companies in planning to provide enough raw materials for maximum chips production. For example the prediction model for raw material (kg) of salted potato is Y = 3933 + 471.4 (X). In the future, the prediction model that obtained will be evaluate using Root Mean Square Error (RMSE), Mean Square Error (MSE) and others to ensure the robustness of the model.

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